

NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE STANDARD

DIKE (ft) CODE 356

DEFINITION

An embankment constructed of earth or other suitable materials to protect land against overflow or to regulate water.

SCOPE

This standard applies to dikes or levees used to prevent or reduce flood damage to land and property, for flow control in conjunction with floodways or to impound or regulate water for fish and wildlife management.

Dikes are divided into classes determined by the value of the land, crops, and other improvements and the hazard to life within the area to be protected.

PURPOSE

To permit improvement of agricultural land by preventing overflow and better use of drainage facilities, to prevent damage to land and property, and to facilitate water storage and control in connection with wildlife and other developments. Dikes can also be used to protect natural areas, scenic features and archeological sites from damage.

CONDITIONS WHERE PRACTICE APPLIES

Class I dikes are those constructed on sites where:

1. Failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways or railroads, and high value land, crops, or other improvements.
2. Unusual or complex site conditions require special construction procedures to ensure satisfactory installations.

3. Protection is needed to withstand more than 12 ft (3.7 m) of water above normal ground surface, exclusive of crossing of sloughs, old channels, or low areas.

Class II dikes are those constructed in highly developed and productive agricultural areas where:

1. Failure may damage isolated homes, highways or minor railroads, or cause interruption in service of relatively important public utilities.
2. The maximum design water stage against the dike is 12 ft (3.7 m).

Class III dikes are those constructed in rural or agricultural areas where:

1. Damage likely to occur from dike failure is minimal.
2. The maximum design water stage against the dike is 6 ft (1.8 m) for mineral soils and 4 ft (1.2 m) for organic soils. (Exclude channels, sloughs, swales, and gullies in determining the design water stage.)

DESIGN CRITERIA - ALL DIKES

In locating dikes, careful considerations shall be given to preserving natural areas, fish and wildlife habitat, woodland, and other environmental resources. If dike construction will adversely affect such values, concerned public agencies and private organizations shall be consulted about the project.

Protection. A protective cover of grasses shall be established on all exposed surfaces of the dike and other disturbed areas. Seedbed preparation, seeding, fertilizing, mulching, and fencing shall comply with recommendations in local technical guides.

If vegetation will not control erosion, riprap or other protective measures shall be installed.

Maintenance. All dikes must be adequately maintained to the required shape and height. The maintenance of dikes must include periodic removal of woody vegetation that may become established on the embankment. Provisions for maintenance access must be provided.

DESIGN CRITERIA - CLASS I DIKES

Location. Conditions to be considered in designing Class I dikes are foundation soils, property lines, exposure to open water, adequate outlets for gravity or pump drainage, and access for construction and maintenance. Mineral soils that will be stable in the dike embankment must be available.

Height. The design height of a dike shall be the design high water depth plus 2 ft (0.6 m) of freeboard or 1 ft (0.3 m) of freeboard plus an allowance for wave height, whichever is greater. Design elevation of high water shall be determined as follows:

1. If dike failure is likely to cause loss of life or extensive high-value crop or property damage, the elevation of design high water shall be that associated with the stage of the 100-year-frequency flood or of the maximum flood of record, whichever is greater.
2. If dike failure is unlikely to result in loss of life or extensive high-value crop or property damage, the elevation of design high water shall be that associated with the peak flow from the storm that will insure the desired level of protection or the 50-year-frequency flood whichever is greater.
3. If the dike will be subject to stages from more than one stream or source, the criteria indicated shall be met for the combination that causes the highest stage.
4. If the dike will be subject to tidal influence as well as streamflow, the streamflow peak shall be assumed to occur in conjunction with the mean high tide to determine the design high water depth.

The design height of the dike shall be increased by the amount needed to insure that the design top elevation is maintained after settlement. This increase shall be not less than 5 percent.

Interior drainage. If inflow from the area to be protected by the dike may result in loss of life or extensive high-value crop property damage, provisions shall be included in the plans to provide interior protection against a 100-year-frequency hydrograph, plus base flow, and an allowance for seepage, and may include storage areas, gravity outlets, or pumping plants, alone or in combination.

If inflow from the area to be protected by the dike is unlikely to result in loss of life or extensive high-value crop or property damage, storage areas, gravity outlets, or a pumping plant, alone or in combination, shall be included in the plans and designed to handle the discharge from the drainage area based on drainage requirements established for the local area or the peak flow from the storm that will insure the desired level of protection, whichever is greater.

In sizing outlet works in combination with available storage, the minimum design storm duration for interior drainage shall be 10 days. If outlet works are designed using peak flood frequency flows without considering storage, the minimum design storm duration shall be 24 hours.

Embankment and foundation. The embankment shall be constructed of mineral soils, which when placed and compacted will result in a stable earth fill. No organic soil shall be used in the dike. Soils must have high specific gravity and be capable of being formed into an embankment of low permeability. The design of the embankment and specifications for its construction shall give due consideration to the soil materials available, foundation conditions, and requirements for resisting the action of water on the face of the dike and excessive seepage through the embankment and the foundation. The design of the embankment and the foundation requirements shall be based on the length of time and height that water will stand against the dike.

Minimum requirements for certain features of the embankment, the foundation, and borrow pits are as follows:

Minimum top width of Class I dikes shall be 10 ft (3 m) for embankment heights of 15 ft (4.6 m) or less and 12 ft (3.6 m) for heights more than 15 ft (4.6 m). If maintenance roads are to be established on the dike top, "turnarounds" or passing areas shall be provided, as needed.

Side slopes shall be determined from a stability analysis, except that an unprotected earth slope on the water side shall not be steeper than 4 horizontal to 1 vertical if severe wave action is anticipated.

If dikes cross old channels or have excessively porous fills or poor foundation conditions, the landside toe shall be protected by a banquette or constructed berm. Banquettes shall be used to provide construction access and added stability if channel crossings are under water or saturated during construction. Banquettes shall be designed on the basis of site investigations, laboratory analysis, and compaction methods. The finished top width of the banquettes shall not be less than the height of dike above mean ground. The finished top of the banquettes shall not be less than 1 ft (0.3 m) above mean ground and shall be sloped away from the dike.

A cutoff shall be used if foundation materials are sufficiently pervious to be subject to piping or undermining. The cutoff shall have a bottom width and side slopes adequate to accommodate the equipment to be used for excavation, backfill, and compaction operations. It shall be backfilled with suitable material placed and compacted as required for the earth embankment. If previous foundations are too deep to be penetrated by a foundation cutoff, a drainage system adequate to insure stability of the dike shall be used.

Ditches and borrow pits. Landside ditches or borrow pits shall be located so the hazard of failure is not increased. Ditches for borrow pits when excavated on the water side of dikes shall be wide and shallow. Plugs, at least 15 ft (4.6 m) in width, shall be left in the ditches at intervals not greater than 400 ft (121.9 m) to form a series of unconnected basins.

Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be:

Fill height	Minimum berm width
Less than 6 ft (1.8 m)	12 ft (3.7 m)
More than 6 ft (1.8 m)	18 ft (5.5 m)

A drainage system shall be used if necessary to insure the safety of a dike. Toe drains, if used, shall be located on the landside and shall have a graded sand-gravel filter designed to prevent movement of the foundation material into the drain.

Subsurface drains shall not be installed, or permitted to remain without protection, closer to the landside toe of a dike than a distance three times the design water height for the dike. If subsurface drains are to be installed or remain closer than the distance stated, protection shall consist of a graded sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

Pipes and conduits. Dikes shall be protected from scour at pump intakes and discharge locations by appropriate structural measures. A pump discharge pipe through a dike shall be installed above design high water, if feasible, or be equipped with antiseep collars.

All conduits through a dike below the design high waterline shall be equipped with antiseep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed water line shall be equipped with a Dayton or a similar coupling to prevent vibration of the pumping plant being transmitted to the discharge conduits.

DESIGN CRITERIA - CLASS II DIKES

Design water stage. The maximum design water stage permitted is 12 ft (3.7 m) above normal ground level exclusive of crossings at channels, sloughs, and gullies.

If the design water depth against dikes, based on the required level of protection, exceeds 4 ft (1.2 m) the design shall be based on at least a 25-year-frequency flood. If this degree of protection is not feasible, the design shall approach the 25-year flood level as nearly as possible, and planned fuse plug sections and

other relief measures shall be installed where appropriate.

Height. The design height of an earth dike shall be the design water depth plus a freeboard of at least 2 ft (0.6 m) or freeboard of 1 ft (0.1 m) plus an allowance for wave height, whichever is greater.

The constructed height of the dike shall be the design height plus allowance for settlement necessary to insure that the design top elevation is maintained but shall be no less than 5 percent of the design height.

Interior drainage. Provisions must be made for adequate drainage for the area to be protected by the dike.

Cross section. The minimum requirements for the cross section of the dike where fill is compacted by hauling or special equipment shall be as follows:

Design water height		Minimum top width		Steepest side slope
ft	m	ft	m	
0-6	(0-1.8)	6	(1.8)	1-1/2:1
6-12	(1.8-3.7)	8	(2.4)	2:1

If soils or water conditions make it impractical to compact the dike with hauling or special equipment, dumped fill may be used and shall have minimum cross section dimensions incorporated in the fill as follows:

Design water height		Minimum top width		Steepest side slope
ft	m	ft	m	
0-6	(0-1.8)	6	(1.8)	1-1/2:1
6-12	(1.8-3.7)	10	(3)	2:1

Side slopes of 3 horizontal to 1 vertical on waterside and 2:1 on landside may be used instead of 2-1/2:1 for both slopes.

The cross sections shall be strengthened or increased as required to provide additional protection against floods of long duration. The top width shall be less than 10 ft (3 m) if a maintenance road is planned on top the dike. "Turnarounds" or passing areas shall be provided as required on long dikes.

The side slopes shall be 3:1 or flatter on the waterside if severe wave action is expected or

if a steeper slope would be unstable under rapid drawdown conditions. Side slopes shall be 3:1 or flatter on both sides where permeable soils of low plasticity, such as SM and ML, are used in construction.

A banquette (or constructed berm) shall reinforce the landside toe if a dike crosses an old channel or if excessively porous fill or poor foundation conditions justify such reinforcement. Such banquettes shall be used if, during construction, the channel crossing is under water or saturated. The top width of the banquette shall be equal to or greater than the fill height of the dike above the top of the banquette unless a detailed investigation and analyses show a different design is adequate.

Foundation cutoff. A cutoff shall be installed if there are layers of permeable soils or layers creating a piping hazard through the foundation at a depth less than the design water depth of the dike below natural ground level. The cutoff trench shall be of sufficient depth and width and filled with suitable soils to minimize such hazard.

Ditches and borrow pits. Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be:

Fill height	Minimum berm width
Less than 6 ft (1.8 m)	10 ft (3 m)
More than 6 ft (1.8 m)	15 ft (4.6 m)

A landside ditch or borrow pit shall be far enough away from the dike to minimize any hazard to the dike because of piping through the foundation.

For dikes having a design water depth of more than 5 ft, (1.5 m), the landside ditch or borrow pit shall be far enough away from the dike so that a line drawn between the point of intersection of the design waterline with the waterside of the dike and the landside toe of a dike meeting minimum dimensional requirements shall not intersect the ditch or borrow pit cross section.

Pipes and conduits. The dike shall be protected from scour at a pump intake and discharge by appropriate structural measures. A pump discharge pipe through the dike shall be installed above design high water, if

feasible, or else equipped with antiseep collars.

All conduits through the dike below the design high waterline shall be equipped with antiseep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed waterline shall be equipped with a Dayton or a similar coupling to prevent vibrations of the pumping plant being transmitted to the discharge conduits.

Drains. Drains shall be used where necessary to insure safety of dikes and shall be located on the land side, have a graded sandgravel filter, and be designed and installed in accordance with Soil Conservation Service standards for such drains.

Field subsurface drains shall not be installed or permitted to remain without protection closer to the landside toe of a dike than a distance three times the design water height for the dike. If such drains are to be installed or remain closer than the distance stated above, protection shall consist of a graded sandgravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

DESIGN CRITERIA - CLASS III DIKES

The design criteria shall be based on site conditions for mineral or organic soils as applicable.

Top width. Minimum top width is 4 ft (1.2 m).

Side slopes. Minimum side slope is 1:1.

Freeboard. The minimum freeboard is 1 ft (0.3 m) plus wave height. The constructed height shall be increased by the amount necessary to insure that the settled top is at design elevation but not less than 5 percent.

Foundation cutoff. A cutoff shall be installed if necessary to insure dike stability.

Ditches and borrow pits. Minimum berm widths between the toe and the dike and the edge of the excavated channel or borrow shall be two times the depth of the ditch but not less than 8 ft (2.4 m).

PLANS AND SPECIFICATIONS

Plans and specifications for constructing dikes shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

PLANNING CONSIDERATIONS FOR WATER QUANTITY AND QUALITY

Quantity

1. Effects upon components of the water budget, especially on volumes and rates of runoff, infiltration, evaporation, and transpiration.
2. Potential for changes in rates of plant growth and transpiration because of changes in the volume of soil water.
3. Effects on downstream flows or aquifers that would affect other water uses or users.
4. Effects on the rate or volume of downstream flow to prohibit environmental, social, or economic effects.

Quality

1. Effect on erosion and the movement of sediment and soluble and sediment-attached substances carried by runoff.
2. Effects on the movement of dissolved substances to ground water.
3. Short-term, construction, and maintenance related effects on the quality of water resources.
4. . Effects on temperature of water resources to prevent undesired effects on aquatic and wildlife communities.
5. Effects on wetlands or water-related wildlife habitats that would be associated with the practice.
6. Effects on the visual quality of water resources.

DESIGN CRITERIA – CLASS II DIKESHEIGHT

The design height of an earth dike shall be the design water depth plus an allowance for freeboard.

The minimum freeboard for dikes having a surface exposure (fetch) for 1000 feet or less shall be not less than 1.0 foot for fill heights of 4 feet and less, 1.5 feet for fill heights of 4 to 8 feet, and 2.0 feet for greater fill heights.

Additional freeboard shall be provided, to contain waves, for dikes having longer surface exposure (fetch) by addition of the following amounts to the applicable freeboard given above:

<u>FETCH</u> (feet)	<u>FREEBOARD</u> (feet)
1001 – 1250	0.2
1251 – 1500	0.4
1501 – 1750	0.6
1751 – 2000	0.8
over 2000	increase proportionally

In areas where dikes will be exposed to wave action for extended periods of time, additional protection will be required. (see Pond 378, Standard)

ALLOWANCE FOR SETTLEMENT

The minimum allowance to be added to the design height for settlement shall be as follows:

<u>DIKES CONSTRUCTED WITH</u>	<u>ALLOWANCE IN PERCENT</u>
Bulldozer and Scrapers	10
Dragline	20

The use of draglines alone is not recommended for dikes with maximum fill heights exceeding 10 feet.

DESIGN CRITERIA – CLASS III DIKES

(For the Purpose of Protecting Agricultural Land of Relatively Low Capability or Improvements of Low Value)

Class III dikes are usually built where the spoil from excavated drainage channels is available. The maximum design water height permitted in this class dike shall be 4 feet above normal ground level for organic soils and 6 feet for mineral soils. This height is exclusive for crossing at channels, sloughs, and gullies. Damages which are likely to occur from a dike failure are low.

The design and installation shall be based on engineering surveys and investigations as provided for:

1. Mineral soils – Sec. 16, Chapter 2, NEH
2. Organic soils – Sec. 16, Chapter 8, NEH

The stage and duration of high water for which protection is to be provided shall be determined from this investigation. Dikes of this class shall provide protection for at least a 10-year frequency flood, except for areas to be devoted to range. Protection for these areas may be provided only for annual high water or annual high tide.

HEIGHT

The height of Class III dikes are determined in the same manner outlined under "Height" for Class II dikes except where no wave action is anticipated a minimum freeboard of 1 foot may be used.

ALLOWANCE FOR SETTLEMENT

The minimum allowance for settlement shall be as required under Class II dikes. In cases where dikes are constructed in slush and mud typical of marshes, at least 50 percent shall be allowed for settlement.

CROSS SECTION

The minimum requirements for the cross section of the dike shall be as follows:

(MINERAL SOILS)

<u>DESIGN WATER HEIGHT</u> FEET	<u>MIN. TOP WIDTH</u> FEET	<u>STEEPEST DESIGN</u> ^{1/} SIDE SLOPE
0 – 2	4	1½:1
2 – 4	6	1½:1
4 – 6	8	1½:1

(ORGANIC SOILS)

<u>DESIGN WATER HEIGHT</u> FEET	<u>MIN. TOP WIDTH</u> FEET	<u>STEEPEST DESIGN</u> ^{1/} SIDE SLOPE
0 – 2	4	2½:1
2 – 4	6	2½:1

^{1/} Where water is likely to remain against dike for extended periods of time (approximately one month or longer) steepest design side slope is to be 2:1 and the minimum top width for organic soil shall be 10 feet.

BERMS

Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow, shall be:

<u>FILL HEIGHT</u>	<u>MINIMUM BERM WIDTH</u> ^{1/}
Under 6 feet	10 feet
Over 6 feet	15 feet

^{1/} A berm is not required for dikes constructed on mineral soil with bulldozers or motor graders if the slope of the upstream borrow is not steeper than the front slope of the dike.

STRUCTURES

All structures through a dike, below the design high waterline, shall be equipped with antiseep collars designed to increase the distance of the seepage line along the structure by at least 15%.

The dike shall be protected from scour at each pump intake and discharge by use of appropriate structural measures.

All structures shall meet the standards and specifications for "STRUCTURES FOR WATER CONTROL", 587.

CORE TRENCH

A cutoff trench will be installed if prescribed by the engineer.

VEGETATIVE COVER

Dikes should be protected from erosion by the use of vegetation, or suitable mulch material until natural vegetation is adequate.

MAINTENANCE

All dikes must be adequately maintained to the required shape and height. Vegetation to control erosion shall be established on dikes as required by climatic conditions and the need for protection against wave action. The maintenance of dikes must include periodic removal of woody vegetation which may become established on the embankment. Design of the project shall include provisions for maintenance access.

DESIGN CRITERIA – CLASS III DIKES

(For the Purpose of Creating New or Developing Existing Wildlife Wetlands)

HEIGHT

The maximum design dike height shall be 4 feet above normal ground level for organic soils and 6 feet for mineral soils. This height is exclusive of crossing at channels, sloughs, and gullies.

The stage and duration of high water for which protection is to be provided shall be that necessary to allow good management and meet the objectives of the wildlife development.

SOILS

The dike shall be constructed on soil suitable for embankment construction, and for structure and embankment foundation.

If the dike is to be constructed in a primary organic material, soil borings will be taken to determine the depth of the organic material. Ordinarily, embankments cannot be constructed in one lift where organic material exceeds 2 feet in depth.

If it becomes necessary to construct a dike with organic material deeper than 2 feet, then (a) suitable mineral earth materials shall be hauled in and used to construct the dike across the area, or (b) the landowner shall be advised of and shall agree to construction period of several months, or years, during which the dike can be constructed in several stages.

EMBANKMENT

The minimum requirements for the embankments shall be as follows:

MINERAL SOILS

<u>DESIGN WATER HEIGHT</u> FEET	<u>MIN. TOP WIDTH</u> FEET	<u>MIN. DESIGN</u> SIDE SLOPE	<u>MIN. 1/ FREEBOARD</u> FEET	<u>MIN. 2/ BERM</u> FEET
0 – 1	0	3:1	0.4	0
1 – 3	4	1 ½ :1	0.8	4
3 – 6	6	2:1	1.0	6

ORGANIC SOILS

<u>DESIGN WATER HEIGHT</u> FEET	<u>MIN. TOP WIDTH</u> FEET	<u>MIN. DESIGN</u> SIDE SLOPE	<u>MIN. 1/ FREEBOARD</u> FEET	<u>MIN. 2/ BERM</u> FEET
0 – 2	4	2 ½ :1	0.8	10
2 – 4	6	2 ½ :1	1.0	15

1/ Where there is no contributing drainage area outside the impoundment, the freeboard shall be added to the normal water surface elevation in the impoundment when it is flooded.

Where there is contributing drainage area outside the impoundment, the freeboard shall be added to the water surface elevation for the emergency spillway when it is flowing at design depth.

- 2/ A berm is not required for dikes constructed on a mineral soil with bull dozers or motor graders if the slope of the upstream borrow is not steeper than the front slope of the dike.
- 3/ Where water is likely to remain against dike for extended periods of time (approximately one month or longer) the minimum top width shall be 10 feet.

Additional freeboard shall be provided, to contain waves, for dikes having longer surface exposure (fetch) by addition of the following amounts to the applicable freeboard given above:

<u>FETCH</u> (feet)	<u>FREEBOARD</u> (feet)
1001 – 1250	0.2
1251 – 1500	0.4
1501 – 1750	0.6
1751 – 2000	0.8
over 2000	increase proportionally

In areas where dikes will be exposed to wave action for extended periods of time, additional protection will be required (see Pond 378, Standard).

ALLOWABLE FOR SETTLEMENT

DRAGLINE CONSTRUCTED

The allowance for settlement shall not be less than 30 percent for clays and silty soils, 20 percent for sandy soils, and 50 percent for organic soils.

BLADE CONSTRUCTED (BULLDOZERS, MOTOR GRADERS AND SCRAPERS)

The allowance for settlement shall not be less than 20 percent for clays and silty soils, and 10 percent for sandy soils.

STRUCTURES

One or more structures shall be provided which will automatically draw water down after rains to the planned surface elevation in the impoundment where there is a contributing drainage area outside the impoundment. Structures shall be sized by the use of the Cypress Creek Formula, with the appropriate "C" value and safety factor.

CORE TRENCH

A cutoff trench will be installed if prescribed by the engineer.

EMERGENCY SPILLWAY

When the impoundment is entirely surrounded by a dike, and has no runoff discharging into it, an emergency spillway is not required.

Where there is a contributing drainage area outside the impoundment, emergency spillway capacity shall be sufficient to carry the maximum outflow expected for a rainfall frequency of one in ten years. Reduction of spillway size due to temporary detention may be considered.

The emergency spillway shall consist of (1) a concrete or earthen spillway, (2) conduit (pipe), or (3) a combination of a concrete or earthen spillway and a conduit.

If an earthen spillway is used, the crest of the spillway shall be at least 0.2 foot above the normal reservoir water elevation.

DRAINAGE

Provisions shall be made to drain water stored in the impoundment area as follows:

<u>FOOD CROP</u>	<u>AVERAGE REMOVAL RATE</u>
Corn, Browntop Millet, Rice	1.5" in 24 hours
Chufas, Japanese Millet	1.0" in 24 hours
Native wetland plants, Bottomland hardwoods	0.5" in 24 hours

Adequate surface drains shall be provided to remove surface water from approximately seventy-five percent (75%) or more of the impoundment area. However, a lesser degree of drainage may be used when recommended by a biologist.

These structures shall consist of one of the following: (1) a weir type drop structure equipped with removable flashboards; (2) a pipe provided with an elbow and riser; (3) a pipe provided with a riser and a gate or plug at the pipe entrance; or (4) a structure of treated timber or concrete approved by the engineer.

Antiseep collars designed to increase the distance of seepage line along the structure by at least 15 percent shall be used when the design water height exceeds 3 feet.

Structures to automatically draw water down are not required where there is no contributing drainage area from outside the impoundment, but are recommended.

All structures shall meet Service Standards and Specifications for "Structure for Water Control", 587.

SPECIFICATIONS

ALL DIKES

All designs and plans shall meet the requirements of the Standard for Dike.

Preparation of sites for dike construction shall be done in a manner which destroys as little vegetation outside the areas to be occupied by dikes and borrow pits as feasible. Special efforts shall be made to save trees of significant value which are not in the area to be occupied by the dike.

Construction operations shall be carried out in a manner to minimize air and water pollution and hold such pollution within legal limits. Bare areas shall be revegetated as soon as practical after earthwork is completed. A minimum area should be stripped of vegetation at any one time to provide an adequate work site.

Disposal of debris from site preparation shall be done in a manner to cause minimum pollution to the environment.

Due to the inaccuracies of the earthmoving equipment commonly used and conditions which dikes are constructed, it is often impractical to obtain exact side slopes as planned.

Dikes will be acceptable where the following conditions are met:

1. The steepest sections of the waterside and landside slopes do not exceed those planned by more than ½ horizontal to 1 vertical.
2. The plotted cross-section of the completed dikes verifies that the

VEGETATIVE COVER

Dikes should be protected from erosion by the use of vegetation, or suitable mulch material until natural vegetation is adequate.

MAINTENANCE

All dikes must be adequately maintained to the required shape and height. Vegetation to control erosion shall be established on dikes as required by climatic conditions and the need for protection against wave action. The maintenance of dikes must include periodic removal of woody vegetation which may become established on the embankment. Design of the project shall include provisions for maintenance access.

minimum (a) top and base widths, (b) fill height, (c) shrinkage allowance, and (d) cross-sectional area below planned top elevation of the dike, with allowance for shrinkage have been met.

On class III dikes which are constructed with soils that do not permit proper shaping, the base width should equal the sum of the planned front and back side slopes times the settled height plus the planned top width. If the side slopes are constructed steeper than required, the constructed top width shall be increased accordingly and the base width shall not be decreased.

CONSTRUCTION – CLASS I DIKES

The dike shall be constructed to the lines and grades as shown on the plans and staked in the field.

FOUNDATION PREPARATION

The foundation area shall be cleared of all trees, stumps, roots, brush, boulders, sod and debris. All channel banks and sharp breaks shall be sloped no steeper than 1:1. Topsoil which is high in organic matter shall be removed. The surface of the foundation shall be thoroughly scarified before placement of the embankment material.

The cutoff trench, where used, shall be excavated to lines and grades as shown on the plans. It shall be backfilled with suitable material in a manner as specified for earth embankments. The necessary compaction shall be obtained by using equipment adapted to side conditions. The trench shall be kept free of standing water during backfill

operations. Material from the cutoff trench may be placed with the dike section if suitable.

STRUCTURE INSTALLATION

For guidance on the installation of structures, refer to the Specification in "Structures for Water Control," 587.

EMBANKMENT CONSTRUCTION

The material placed in the fill shall be free of all sod, roots, stones over 6 inches in diameter, and other objectionable material. Placing and spreading of the fill material shall be started at the lowest point of the foundation and the fill material shall be started at the lowest point of the foundation and the fill shall be brought up in horizontal layers of approximate uniform thickness, preferably 6 inches thick but not more than 12 inches thick, depending on the equipment used. The construction equipment shall be operated over the area of each layer in a way that will result in the required compaction. Special equipment shall be used when the required compaction cannot be obtained without it.

The distribution and gradation of materials throughout the fill shall be such that there will be no lenses, pockets, streaks, or layers of material differing substantially in texture and gradation, the more impervious material shall be placed in the upstream and center portions to the fill.

The moisture content of fill material shall be such that the required degree of compaction can be obtained with the equipment used.

CONSTRUCTION – CLASS II DIKES

The dike shall be constructed to the lines and grades as shown on the plans and staked in the field.

FOUNDATION PREPARATION

The foundation area shall be cleared of all trees, stumps, roots, brush, boulders, sod and debris. All channel banks and sharp breaks shall be sloped no steeper than 1:1. Topsoil which is high in organic matter shall be removed. The surface of the foundation area shall be thoroughly scarified before placement of the embankment material.

The cutoff trench, where used, shall be excavated to lines and grades as shown on the plans. It shall be backfilled with suitable material in a manner as specified for earth embankments. The necessary degree of compaction shall be obtained by using equipment adapted to site backfill operations. The

material from cutoff trench may be placed within the dike section if suitable.

EMBANKMENT CONSTRUCTION

The embankment material may be obtained from a selected borrow area or from a channel. In the construction of borrow trenches on the water side of the dike, an unexcavated plug at least 25 feet wide shall be left at intervals not to exceed 1320 feet.

The fill material shall be free of organic matter and other objectionable material except organic material may be used in the outer shell. Placing and spreading of fill by hauling or blade equipment shall begin on the lowest part of the working area and continue in horizontal layers of approximate uniform thickness, preferably 6 inches thick but not more than 18 inches thick, depending on the equipment used. Where the borrow yields materials of varying texture and gradation, the more impervious material shall be placed toward the water side of the dike. The construction equipment shall be operated over area of each layer in a manner to break up large clods and obtain compaction.

Fill material shall be moist but not too wet for equipment operations and shaping. Water shall be added to the fill material where it is too dry to dry to permit compaction.

Dumped fill, where used, shall be placed in layers or deposited in a manner suitable to the equipment used and the material excavated. Shaping shall be done so as to break up lumps and clods of earth. Excessively wet material shall be placed to permit free drainage and shaped after it has drained. When the fill slumps due to wetness, the dike shall be constructed in stages.

CONSTRUCTION – CLASS III DIKES

The dike shall be constructed to the lines and grades as shown on the plans and staked in the field.

EMBANKMENTS

Mineral soil materials shall be used in construction, when available. In organic soils the top 2 feet of the borrow area shall be placed on both sides of the embankment to serve as retaining walls.

FOUNDATION

The site shall be cleared of trees, stumps, brush, other vegetation, and debris. This material shall be pushed outside the base of the fill and the surface shall be scarified.

CORE TRENCH

When specified in the plans, a core trench shall be excavated deep enough to penetrate impervious material, and enough to accommodate construction equipment.

STRUCTURE INSTALLATION

For guidance of the installation of structures, refer to the specification in "Structures for Water Control," 587.

CHECKING FOR COMPLETION

Dikes shall be checked for completion in accordance with the procedures given in "Notekeeping for Dikes."

NOTEKEEPINGDESIGN SURVEY

In marshes areas soil borings shall be made to determine the depth of organic material and semi-fluid clays. On other lands, borings shall be made to determine suitability of material of material for construction and depths of permeable soils or layers creating piping hazards.

A profile of the centerline of the proposed embankment shall be taken as needed to permit determination of fill heights and yardage to be moved.

Distances shall be chained if an accurate yardage figure is needed, otherwise they may be paced, or scaled from an aerial photo.

Prepare plan of dike system with location of structures which affect the system.

CONSTRUCTION LAYOUT

Set fill and slope stakes as required. Stake locations and elevations of inlets and outlets of pipes or conduits and spillways.

CONSTRUCTION CHECK

In marsh areas visually observe all of the completed dike system. Take a representative cross section at a minimum of every 1,000 feet, and other questionable locations. Also take center line and normal marsh elevations readings at all areas that appear not to meet the minimum height requirements and at both ends. Record cross

section data, dimensions, elevations and kind of material used for all structures.

In other lands profile the centerline of the dike taking readings every 200 feet and measure the top width. Take representative cross sections of the dike at least every 500 feet. Record profile, cross section data, dimensions, elevations and kind of material used for all structures.

CERTIFYING YARDAGE AND STRUCTURES

The extent of this practice to be certified for marsh land is planned yardage, with allowance for shrinkage, and the structures installed to the specified dimensions. The extent of this practice to be certified for other than marsh lands shall be the planned settled yardage, and the structures installed to the specified dimensions. Yardage shall not be certified in excess of that actually moved.

RECORDING DATA

Field notes will be recorded in looseleaf or bound field notebooks. Record practice name, and draw sketch of the dike system on bound or looseleaf field notebook paper.

Check the notes carefully to determine that all specifications have been met. Date and sign statement, "This practice meets specifications". Note any exceptions.

RECORDING COMPLETED PRACTICE

Show completed dike system in red on field office copy of construction map, or, if not available, on an aerial photograph or overlay.

FILING NOTES AND RECORDS

See General Manual 120, Administrative Services; Part 400, Records; Subpart D, Exhibits; 210, Engineering; 210-11, Conservation Practices.